Incidentally the principle of calibrating retardation devices with the aid of a spectrometer is also illustrated.

An instructive variation of the experiment is to arrange both polaroids to rotate synchronously, which demonstrates that, as a crystal is brought from a position of maximum illumination to extinction, the amplitudes of the light waves passed by the analyzer vary, but the phase relations remain unchanged.

An interesting modification for advanced students of crystal optics would be to substitute for the quartz wedge a wedge of a substance showing strongly "anomalous" interference colors. If a substance exhibiting considerable dispersion of birefringence were substituted for the quartz, the interference bands would not be segments of straight lines passing through the extrapolated zero wavelength. In this case the retardation scale would be different for each wavelength. Even in the case of the quartz wedge the bands do not intersect at the origin; actually they intersect on the positive side of the wavelength zero. The displacement is of the order of 50 $m\mu$ which is in agreement, within the large experimental error, with published data on the indices of quartz.[1]

Photographs essentially similar to Figs. 2 and 3 were published by Hauswaldt.[2]

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[1] Handbook of Chemistry and Physics, edited by Charles D. Hodgman and Harry N. Holmes, Chemical Rubber Publishing Company, Cleveland, Ohio, 1941, p. 2103.

[2] Hauswaldt, Hans, Interferenzerscheinung im Polarisirten Licht, Neue Folge, 1904, Plates 26, 27, 28.

## THE PRIMITIVE CELL OF JOHANNITE

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The pseudo-monoclinic cell of johannite $Cu(UO_2)_2(SO_4)_2(OH)_2 \cdot 6H_2O$ (Peacock, 1935), with morphological axial elements

$$a:b:c = 0.9182:1:0.3799,$$
$$\alpha = 90°54\tfrac{1}{2}', \quad \beta = 90°38', \quad \gamma = 110°37',$$

is all-face-centered ($F$). The cell obtained from it by transformation $\frac{1}{2}0\frac{\bar{1}}{2}/0\frac{\bar{1}}{2}\frac{\bar{1}}{2}/001$ (Hurlbut, 1950; quoted by Palache, Berman, and Frondel, 1951) is primitive ($P$) but unconventional in that it is referred to a left-handed system of coordinates.[1]

The conventional $P$ cell is obtained from the $F$ cell by transformation $\frac{\bar{1}}{2}0\frac{\bar{1}}{2}/0\frac{\bar{1}}{2}\frac{\bar{1}}{2}/001$. The axial elements, calculated from Peacock's numerical values, are

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[1] The figure given by Hurlbut (1950, p. 533) should be relabelled as follows. Instead of $c_0$ read $-c_0$ and instead of $c_0'$ read $-c_0'$. For each cell the origin is to be taken at the lattice node where the three labelled edges meet.

$$a:b:c=0.9305:1:0.7140,$$
$$\alpha=110^\circ\ \tfrac{1}{2}',\quad \beta=111^\circ 59',\quad \gamma=100^\circ 18''$$

The lengths of the primitive translations follow from Hurlbut's $c$ value. They are:

$$a=8.90\text{ kX},\quad b=9.57\text{ kX},\quad c=6.83\text{ kX},\quad \text{with}\quad V=474.4=1897/4\text{ kX}^3;$$

or

$$a=8.92\text{ Å},\quad b=9.59\text{ Å},\quad c=6.84\text{ Å},\quad \text{with}\quad V=477.1=1908/4\text{ Å}^3.$$

This cell is the Delaunay reduced cell (with all three angles obtuse, Dalaunay, 1933; Donnay and Nowacki, 1954, pp. 139–141). It happens to be defined by the shortest three translations of the lattice (its $a$ length is shorter than Hurlbut's $a_0'$).

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# STUDIES IN THE MICA GROUP; MANGAN-MUSCOVITE FROM MATTKÄRR, FINLAND

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In a series of recent papers Heinrich and Levinson (1955*A*, 1955*B*) and Levinson (1955) have reported a significant frequency of polymorphism among muscovite-type (heptaphyllite) micas. It has been noted, moreover, that these micas exhibit considerable isomorphous substitution when compared with the ideal or theoretical muscovite composition. Significant contents of $V_2O_3$, BaO, $SiO_2$ or $H_2O$ characterize the muscovite-type micas that have crystallized as the 1-layer monoclinic (*1M*) or 3-layer trigonal (*3T*) polymorphs, although some of these, particularly the high $SiO_2$ and $H_2O$ varieties, also have crystallized with the common 2-layer monoclinic (*2M*) structure. Previously it had been generally accepted, on the basis of the work of Hendricks and Jefferson (1939), that muscovite occurs only as the *2M* polymorph. Axelrod and Grimaldi (1949), however, described a muscovite from Sultan Basin,

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* Contribution from the Department of Mineralogy and Petrography, University of Michigan, No. 193.